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ABSTRACT

A laboratory and a classroom study were conducted to determine if verbal association learning would be facilitated by visual discrimination training. Kindergarten children who could not recognize the letters used were the subjects for both studies. In the laboratory study, 90 subjects were randomly assigned to the experimental group (E) which got visual discimination training focusing attention on distinctive features of letters b, d, p, and q: to control group one (C-1) which got visual discrimination training without attention to distinctive features; or to control group two (C-2) which was exposed to the same materials but not to the training. The results indicated that group E learned letter names significantly better than did either of the control people. In the classroom study, 203 subjects were randomly assigned to groups as before. Instruction consisted of giving visual discrimination training, letter-name training, and workbook exercises in which groups E and C-1 were required to match letters and group C-2 matched geometric shapes. No significant differences were noted for any of the groups. It was concluded that while the theoretical rationale was sound, classroom procedure was at fault in the second study. Tables, sample materials, and a bibliography are included. (Author/MS)

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FINAL REPORT

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S. Jay Samuels
University of Minnesota
Minneapolis, Minnesota 55455

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PREFACE

This report was made possible through the cooperation of many individuals.

Appreciation is extended to Mr. Teara Archwamety, who collected data for the laboratory study and did the data analyses for the two studies, and to Miss Gloria Benson, who prepared the stimuli for the workbooks used in the classroom study and typed the final report.

Dr. Richard Faunce, of the Minneapolis Board of Education, helped us to obtain subjects for the laboratory study.

The principals in the Minneapolis schools: Mrs. Matsolonie Pullens, Mr. George Lillquist, Mr. George McDonough, and Dr. Arthur Jensen -- the teachers: Mrs. Mildred Bulluck, Miss Jean Townsend, Mrs. Barbara Kydd, Mrs. Jewel Malerich, Miss Jacqueline Anderson, and Mrs. Unice Lundberg -- and the research assistants: Mary Anderson, Harriet Levy, Sheri Robertson, Marilyn Seeman, Lonna Nelson, Nancy DeBoer, Joyce Couch, Carol Chapman, Harriet Flasher, Katherine Beecham, Charmaine Clark, and Mary Brinda -- all made possible the completion of this study.

Finally, without the help of the children, we would not have learned what we now know about teaching letter-names.

An Experimental Program for Teaching

Letter Names of the Alphabet

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ABSTRACT

A laboratory and classroom study were conducted to determine if verbal association learning could be facilitated by visual discrimination training which focused attention on the distinctive features of each of the stimuli.

In the laboratory study, ninety kindergarteners were randomly assigned to one of three treatment groups. None of the children could identify the letters used in the study. Experimental group (E) got visual discrimination training which forced attention to the distinctive features of letters b, d, p, q. Control group one (C-1) got visual discrimination training on the same letters, but attention was not drawn to the distinctive features.

Visual discrimination training of C-1 was similar to that found in many reading readiness programs in which discrimination training is given but does not force attention to the distinctive features which make each letter unique in appearance and identifiable from all the other letters in the alphabet. Control group two (C-2) was exposed to the same materials as group E, but did not get visual discrimination training. Following discrimination training, all groups received letter-name instruction using a paired-associate anticipation procedure.

Comparing group E versus C-1 and C-2, the results indicated that group E learned letter names in significantly fewer trials ($p < .01$) with significantly fewer errors ($p < .01$). Differences between C-1 and C-2 were not significant.

Inability to learn letter-names by trial number twenty was used as an index of failure. The failure rate for the group was: Group E = 20%, Group C-1 = 43%, Group C-2 = 60%.

In the classroom study, 203 children were randomly assigned to the same three groups (E, C-1, C-2) as in the laboratory study. A total of 14 letters were taught in four weeks. The children were pre-tested, post-tested, and given weekly tests. Instruction consisted of giving visual discrimination training followed by letter-name training. Analysis of variance indicated that differences among the groups were not significant.

The success of the laboratory study suggests that the theoretical rationale is sound. Lack of success in the classroom study suggests the classroom procedure is at fault. The report contains a comprehensive set of recommended procedures based on ex post facto analysis of the classroom study which should result in improving classroom instruction. These recommendations include letter combinations to use as well as the need to develop high-speed automatic-distinctive feature recognition.

An Experimental Program For Teaching

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INTRODUCTION

This research is directed at the problem of devising an effective way to teach children to name letters of the alphabet. Although the focus of the study is upon the specific problem of teaching letter names, in the broader context, the instructional problem this research addresses itself to is basically one of how to facilitate associational learning.

Learning to name letters of the alphabet is similar in many ways to learning to identify and name flowers, animals, birds, airplanes, and numerous other objects in our environment. Thus, the instructional problem faced in this research has implications that extend beyond the immediate task of devising a more effective way to help children learn the names of letters in the alphabet. Although the research undertaken in this study is on letter-name learning, it has broad implications for instruction in associational learning.

Historically, associational learning was believed to be a simple single stage process. As psychologists continued to investigate the nature of associational learning, they discovered that S-R learning was anything but a simple, single stage process. Gibson (1940) detailed the importance of stimulus learning in the associational process. Morikawa (1959) postulated that there were three distinctly different types of learning involved in paired-associate learning: stimulus discrimination, response acquisition, and reinforcement of S-R paired-associates. Underwood and Schulz (1960) divided paired-associate learning into a response learning stage, and a hook-up stage in which stimulus and response are joined. McGuire's (1961) model was similar to the Underwood and Schulz model, except for the hook-up stage. McGuire postulated a more complicated mediational stage. The importance of this mediational stage in associational learning has since been documented by the work of Martin, Cox, and Boersma (1965). The recent work of Rohwer (1970), Davidson (1964), and Turnure and Walsh (1970) indicates

that S-R hook-up is facilitated by psycholinguistic processes such as syntactic elaboration.

The division of associational learning into numerous components has extended beyond three stages. For example, Travers (1967) has stated that in verbal and symbolic learning, the input stage can be divided into a phase in which information is contained in a preperceptual field, a phase in which some of the information from the preperceptual field is selected and stored in short term memory, and a stage in which selected information in short term memory is transfered to long term memory by being hooked-up to previously stored information held in long term memory.

The research literature currently provides evidence for the following processes in the early stages of learning to read: attention, distinctive feature learning, visual recognition memory, S-R mediation and hook-up, auditory discrimination, and auditory memory. This testing of factors involved in the associational process indicates how far psychologists have traveled since the early days of thinking of associational learning as a simple, one-stage process.

The proliferation of stages and processes in associational learning has important functions. First of all it represents a better understanding of what is involved in S-R learning. Second, each seperate stage which is identified becomes a focal point for concentrated research in that area. Third, and most important from an instructional viewpoint, as we add to our knowledge of stages and processes, we learn more about how to facilitate associational learning.

Letter-name learning, which is an associational process, is an important part of reading readiness programs. At one time, the task of teaching children to name letters was assigned to first grade. However, with the present trend towards introducing more academic activities into the kindergarten curriculum, kindergarten teachers are now assuming the responsibility of providing this instruction.

Despite instruction in letter-name learning, numerous children have difficulty with this task. Muehl and Kremenak (1966) wrote, "The children in this study had received systematic instruction in letter names and sounds during the latter half of the kindergarten year. Thus, deficiencies in letter-name knowledge existed in the first grade level despite this instruction." Muehl's observation supports what school teachers frequently report. After what appears to be an adequate amount of time devoted to

teaching the alphabet, some children continue to have difficulty identifying all the letters. Their difficulty is especially apparent with letters having similar appearance, such as p, q, b, and d.

After examining numerous reading readiness programs, Dykstra (1967) concluded that they were ineffective in promoting reading achievement.

The reading readiness work books and the visual discrimination exercises used in schools as part of the readiness programs often have children discriminate among a set of low similarity figures such as circles and squares or baloons and kites. The discrimination tasks become progressively more difficult by having the children discriminate among high similarity figures. Letters are later introduced into the discrimination program requiring the children to find the matching letters in a set such as:
a b, a, x, m.

The rationale governing the type of visual discrimination program just described, which is commonly used in commercial work books and by teachers, is that in order to learn letter names, one must be able to visually discriminate the letters. Consequently, the student is given discrimination training in the belief that it will transfer to learning letter names. What is naive about the approach is the assumption that any kind of discrimination training will have transfer value, such as discriminating among geometric forms, objects, or any combination of letters in the alphabet.

Kindergarten and first grade children have already learned to make numerous gross and fine discriminations. Their ability to name objects in their environment (such as "tree," "plant," "flower," "dog," "cat") or to identify people by name testifies to this. What the children need in order to name letters is not just any kind of discrimination training. What is required is visual discrimination training which will help them to note the unique features of letters, features which make each letter different and identifiable.

The task of learning letter names of the alphabet is similar to the task of learning to identify birds. Actually, bird identification is a more difficult task. While there are only 26 letters of the alphabet, there are more than 800 species of birds on the North American continent. Numerous states in the United States have several hundred species within its borders.

During Audubon's day the only sure way to identify a bird was to kill it and compare it to some field guide. Today the bird watcher does not have to kill the bird to be sure of its identity. The modern field guide has arrows which direct attention to the unique features of a bird. Once these unique features--or distinctive features--have been observed on a bird, identification is relatively simple. The same system of directing attention to unique features was used to identify airplanes during the second world war.

The assumption being tested in this research is that letter-name learning is an associational process. The associational process is complex and can be facilitated by simplifying the learning connected with any of the components of the process. In the case of letter-name learning, the children can be helped by giving them prior training on discriminating and noting the unique, distinctive features of letters. In essence, the technique being employed is identical to that which has been employed successfully in bird and airplane identification.

Specifically, it is proposed that children are aided in learning letter names through instruction which:

1. first gives visual discrimination training without attaching verbal labels.

2. forces attention to the distinctive features of letters by having children visually discriminate among easily confused (high similarity) letters.

3. attaches verbal labels to visual stimuli after visual discrimination training.

Outline of Research Design and Procedure for Laboratory and Classroom Study. A randomized group design with one experimental group and two control groups is used.

	Group		
	Experimental	Control-1	Control-2*
Visual Discrimination Training	Visual discrimination training on distinctive features of letters	Visual discrimination training, but not on distinctive features of letters	Exposure to same stimuli used in Group E, but no visual discrimination training
Transfer to Learn Letter Names	All groups get same letter-name training.		

* In classroom study, students received stimuli different from E.

REVIEW OF THE LITERATURE

Visual Discrimination of Letters and Words. Muehl (1960) compared the effects of visual discrimination training on the same or different words used in reading instruction on learning to recognize these words. He found that visual discrimination training on the same words used in reading instruction was superior.

King (1964), however, obtained results which ran counter to Muehl's 1960 results. King found significant differences in reading performance favoring pre-training on matching different words. She also found pre-training on the same letters used later in teaching particular words facilitated reading performance.

Muehl (1961) attempted to find out why, in his 1960 study, visual pre-training on the same words used in reading instruction was more effective than training on different words. Specifically, he tested to find if it was attention to the individual letters in the word, or to the whole word, which was important. He found no difference between relevant letter and relevant word pre-training. His failure to find differences may be explained by an error in the design which changed the word discrimination task into what was essentially a letter discrimination task.

Left-Right Motor Response Pre-Training. Jeffrey (1958) and Hendrickson and Muehl (1962) had children make a left motor response to "d" and a right motor response to "b". Children who had motor response pre-training were superior to their controls in learning to name these letters. These results were interpreted to indicate the importance of motor responses as a mediational factor in learning. Today these results are interpreted to mean that attention was focused on the relevant dimension of difference between the letters.

A Confusion Matrix - Determining Distinctive Features of Letters From. Gibson, et al (1963) presented capital letters to four-year-old children. Their task was to select a letter from a series which was the same as a standard. An analysis of the mistakes made on this matching-to-sample task indicated that the children tended to choose letters which shared similar distinctive features as the standard. For example, if the standard was letter "C", the mistakes tended to be "G", "O", "Q", and "U". From these mistakes a confusion matrix was constructed indicating which letters share common distinctive features and thus tend to be confused.

More recently, Gibson, Schapiro, and Yonas (1968) obtained a confusion matrix from a set of nine Roman capitals. Both adults and seven-year-old children participated. Subjects made same-different judgments to letter pairs. Latencies were analyzed by a hierarchical cluster analysis. The results confirmed the hypothesis that letters are distinguished from one another by distinctive features.

Popp (1964) used a procedure which was highly similar to the Gibson, et al 1963 procedure, only lower-case letters were used. This data provided a confusion matrix for lower-case letters, while the Gibson work has done this for upper-case letters.

These confusion matrices provide information which is useful for designing instructional materials which train on noting distinctive features. It would seem highly desirable to replicate the Popp study using the same-different latency procedure.

Transfer of Distinctive Feature Training. Pick (1965) found that if kindergarten children noted dimensions of difference (i.e., distinctive features) of letter-like forms, they made fewer discrimination errors on a transfer task containing stimuli which looked different from those used in training, but which contained the same dimension of difference. This study is important because it indicates the positive transfer value of dimension of difference training.

Pick, Pick and Thomas (1966) found that dimension of difference training can transfer from one sense modality to another. First grade children were blind folded and given form discrimination training on a set of three-dimensional letter-like forms. The subjects had to discriminate tactually among the letters on the basis of distinctive feature differences. The blind folds were removed and they were shown the same forms as printed letters and were required to visually discriminate among them. The authors found that training in one modality could transfer to another, and subjects trained to note distinctive feature differences made fewer errors on the transfer task.

Caldwell and Hall (1969) gave visual discrimination training to kindergarteners. The first group was given two-dimensional forms differing in orientation. They were told that if the two-dimensional forms differed in orientation, they should be judged differently. A second group was given the same forms without instructions. A third group received forms which did not differ in orientation and were uninstructed about orientation. Following training,

all groups received a test requiring discrimination among geometric forms having orientational differences. The results indicated that the best transfer resulted from instruction and training on orientational differences.

Effects of Instructions and Sequence of Stimulus Presentation. Meinke and Klausmeier (1968) investigated the effects of instructions that convey information, a strategy, and a principle upon the acquisition of concepts that vary in relevant and irrelevant dimensions. Their results pointed to the importance of manipulating instructions to facilitate concept attainment.

Ackerman and Williams (1968) investigated the relative difficulty of simultaneous and successive discrimination of similar letters (b, d) and dissimilar letters (b, s). They found no significant difference between either method of stimulus presentation. There was some indication that with similar stimuli, successive discrimination was easier. With dissimilar stimuli the simultaneous discrimination was easier. In a follow-up study, Ackerman and Williams (1970) have subsequently found with highly similar trigrams, that successive discriminations resulted in reliably better learning.

Samuels (1969) gave visual discrimination training to kindergarteners on letters b, d, p, q. One group was given simultaneous matching-to-sample training (all letters present at the same time). A second group got successive matching-to-sample training (letter "b" shown by itself, then removed. Student then told to select the matching letter from the set, b, d, p, q). Following simultaneous or successive training, both groups were trained to name the letters. The results indicated reliably better learning for the successively trained group. Superiority for the successively trained group is thought to result from improvement in visual memory under successive training.

EXPERIMENT ONE - LABORATORY STUDY

Method

Subjects. In order to select subjects who would be appropriate for the study, 237 kindergarteners from three elementary schools in Minneapolis were pre-tested to determine knowledge of the four letters "b", "d", "p" and "q".

Two methods were used to test this knowledge. In the first method, the experimenter showed the subject four 5 X 8 inch cards, one at a time, on which the letters b, d, p, q were typewritten, one to a card. The experimenter pointed to a letter and asked, "What letter is this?"

In the second method, the experimenter showed the subject four 5 X 8 inch index cards, one at a time. Each card had the letters "p", "q", "b", "d" typed on it in a different order. The subject was shown a card and asked to point to a letter named by the experimenter.

Each kindergartener was tested with both methods. Those responding correctly more than once in either method were eliminated.

Ninety subjects were randomly selected and randomly assigned to one of three groups, the Experimental Group (E), Control Group One (C-1), and Control Group Two (C-2). Each subject in C-2 was randomly paired, or yoked, to a subject in E.

Materials

Warm-up. All subjects, regardless of group, were given warm-up training to acquaint them with the task involved in learning to associate a letter-name with a letter symbol. The warm-up materials consisted of three 5 X 8 inch index cards, each having one of the following pictures: a boy, a different boy, and a girl.

Visual Discrimination and Transfer Stimuli for E and C-2

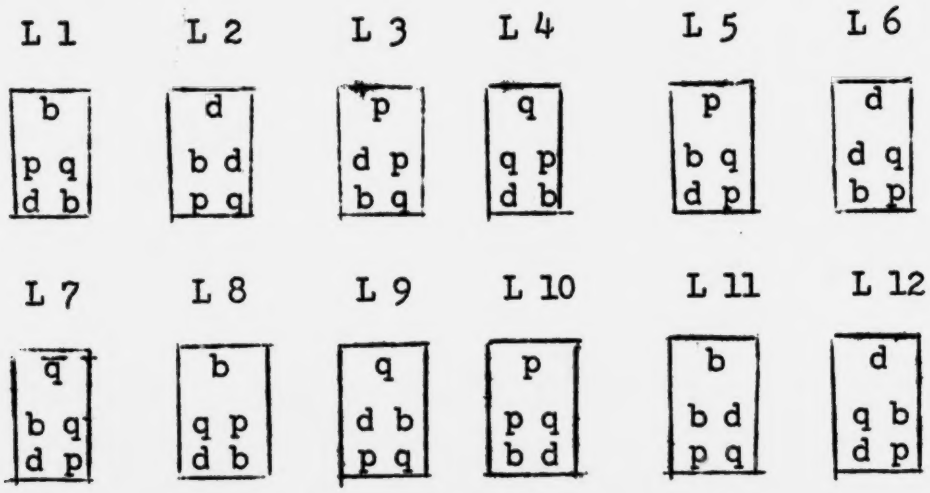
A special 9 X 11 inch book containing 48 transparent plastic leaves was used to present and protect the stimuli. Only one side of each leaf was used. The book was divided into three sections, 12 leaves in the first for simultaneous visual discrimination training, 24 leaves in the second for successive visual discrimination training, and 12 leaves in the third for transfer of training (i.e., learning to name the letters).

See Figure One for the stimuli used on each of these pages.

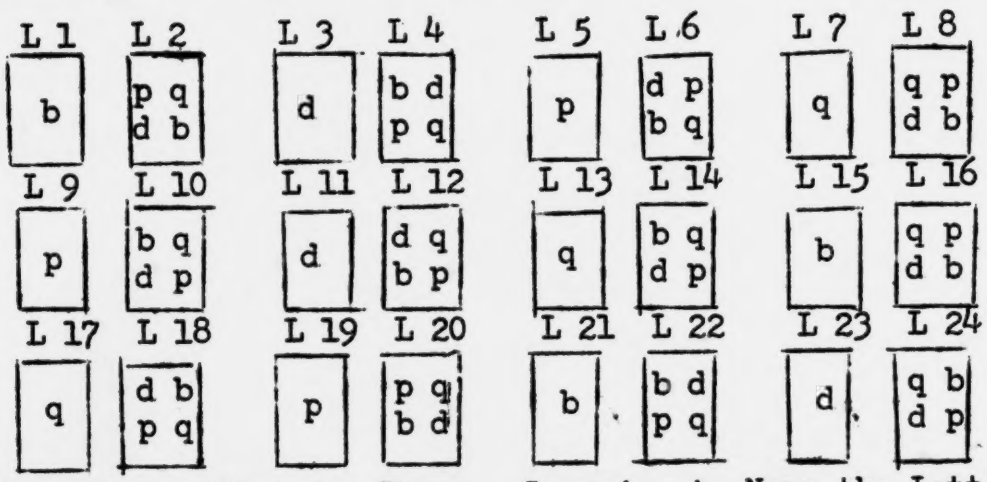
Stimuli used for the Experimental & Control - 2 Groups.

L = Leaf

<u>1st Section</u> - Visual Discrimination Training - Simultaneous



<u>2nd Section</u> - Visual Discrimination Training - Successive



<u>3rd Section</u> - Transfer Phase - Learning to Name the Letters

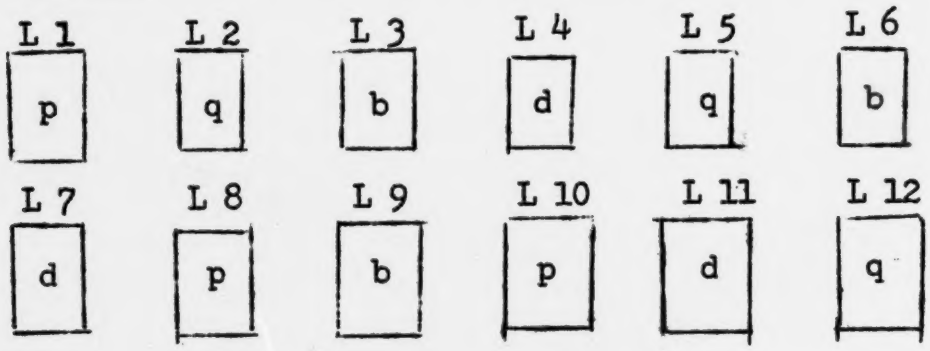


Figure 1

Visual Discrimination and Transfer Stimuli for C-1
The same format was used in the book for C-1.

See Figure Two for the stimuli used on each of these pages.

Procedure

The experimenter worked with one subject at a time in a room free of distraction.

E Subjects:
Retest. Subjects were retested to ensure they could not name the letters using the same procedure used previously.

Warm-up. After retesting, the subject was given the following instructions:

> "We are going to play a game. I am going to show you pictures of children. You must try to learn their names. In this game you must say their names before I say them. What must you do?"

If the subject indicated he understood the directions, the experimenter proceeded with the first trials; if not, the directions were repeated until the subject gave an appropriate response.

Standard paired-associate anticipation procedure was used to pair the name of a person with a particular picture. The three cards were presented in random order until the subject gave the correct name for the three cards on the same trial. Exposure time for each card was about 6 seconds. The interval between exposures was about 2 seconds.

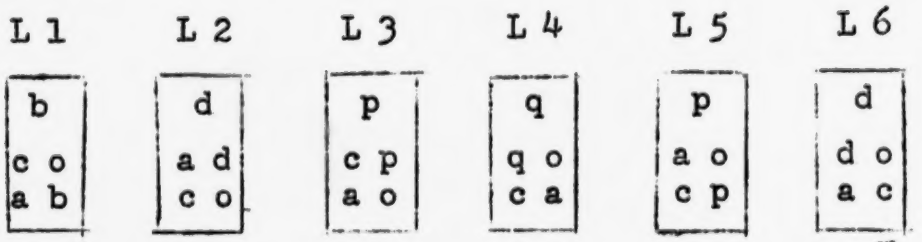
Visual Discrimination Training. Immediately upon completing the warm-up, visual discrimination training was given. During visual discrimination, the mode of stimulus presentation was simultaneous matching-to-sample followed by successive matching-to-sample.

In the simultaneous mode, all the stimuli were present together, permitting the subject to look back and forth from the standard letter at the top to the alternatives below (See Figure No. 1).

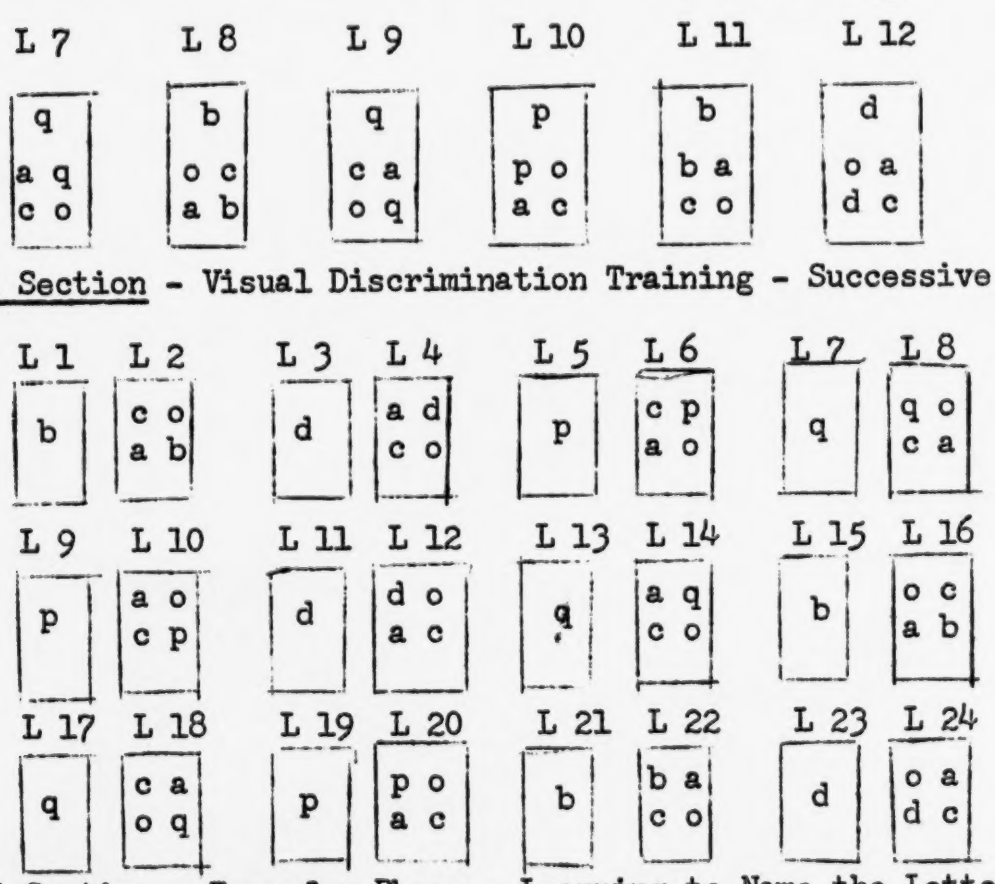
Stimuli Used Control - 1

L = Leaf

<u>1st Section</u> - Visual Discrimination Training - Simultaneous



<u>2nd Section</u> - Visual Discrimination Training - Successive



<u>3rd Section</u> - Transfer Phase - Learning to Name the Letters

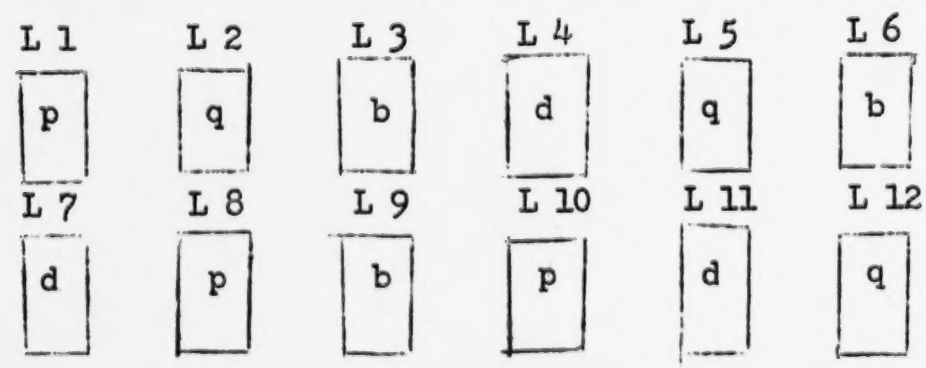


Figure 2

Instructions for the simultaneous mode were:

> "Point to the letter at the top. Look at it. Now find the letter below that looks just like the letter at the top. Point to it."

The card was exposed for about 4 seconds during which time the subject had to respond. If correct, he was given feed back, if wrong, the experimenter pointed to the correct response.

Position of letters on each card was random. The subject was given discrimination training in the simultaneous mode until he got two successive trials correct in a row.

In the successive mode, first the standard was shown by itself for about 2 seconds. Then the page was turned and just the response alternatives were shown for about 4 seconds. Instructions were:

> "Look at this letter."
>
> (The page was turned)
>
> "Now, point to the letter on this page which looks just like the letter you looked at on the other page."

Feedback was given for all responses. Letter position on each card was randomized.

Criterion was reached when the subject gave error-free responses for two consecutive trials.

Transfer of Learning. Immediately following criterion on visual discrimination, the transfer task of learning letter names was given. The instructions were:

> "We are going to play a game just like the game we played before (point to the warm-up materials). I am going to show you a letter. You must tell me what name goes with the letter before I tell you. Do you understand? When must you say the name of the letter?"

Standard paired-associate anticipation procedure was used. For the first trial, the experimenter presented each of the four letters in succession, said the letter-name, and had the subject repeat. For the subsequent trials, each letter was exposed for 6 seconds. If the subject did not

give the correct letter-name during this interval, the experimenter gave the name. The cards were presented in fixed random order. Criterion was reached when the subject gave four correct responses for a trial, or the 30th trial, whichever came first. (Note: The procedure for learning letter names was exactly the same for Groups E, C-1, and C-2.)

C-1 Subjects:

Retest. C-1 subjects were given the same retest described earlier.

Warm-up. C-1 subjects were given the same warm-up described earlier.

Visual discrimination. Each C-1 subject underwent the same visual discrimination procedure as did subjects in Group E, only C-1 subjects used a different set of stimuli. These stimuli can be seen in Figure 2.

Transfer of Learning. The procedure for learning letter-names was the same as that used by Group E.

C-2 Subjects:

Each subject in C-2 was randomly paired, or yoked, to a subject in E.

Retest. C-2 subjects were given the retest described earlier.

Warm-up. C-2 subjects were given the same warm-up exercise described earlier.

Visual Discrimination. Each C-2 subject was exposed to exactly the same stimuli for the same number of trials as his yoked mate in Group E. The critical difference was that C-2 subjects did not engage in visual discrimination. The procedure for the simultaneous and successive presentation was as follows: the experimenter pointed to the standard letter at the top and to the correct matching alternative below or on the next page. The C-2 subject imitated by pointing to the designated letters. Thus, he had equal exposure, but not the active experience of discriminating and selecting the letters.

Transfer of Learning. The procedure for learning letter names was the same as that used for Group E.

RESULTS

Several analyses on the data were performed.

The first analysis was on trials to criterion, or the 30th trial, whichever came first. Criterion was naming the correct letters on the same trial for b, d, p, q.

Table One shows means and standard deviations for trials to criterion in visual discrimination training and transfer of learning.

Table Two shows the analysis of variance on trials to learn the letter names.

Planned comparisons on trials to criterion indicated that the differences between E versus C-1 and C-2 was significant ($p < .01$). Group C-1 versus C-2 was not significant. Thus, Group E learned in significantly fewer trials, whereas there was no significant difference between C-1 versus C-2 in speed of learning.

The second analysis was on errors to criterion. The mean number of errors to criterion for each of the groups was: Group E = 28.30 (SD = 24.29), Group C-1 = 48.97 (SD = 33.92), Group C-2 = 51.97 (SD = 28.01).

Table Three shows the analysis of variance for errors to criterion on learning letter names.

Planned comparisons on errors to criterion indicated no significant difference between C-1 versus C-2. Comparing Group E versus C-1 and C-2, the analysis indicated E learned with significantly fewer errors ($p < .01$).

Perhaps, one of the more important comparisons is on the number of trials to reach criterion for each of the groups. Table Four indicates this comparison.

Table 4 shows a general trend. Seventy-two percent of the subjects in Group E have reached criterion by trial number 20. In C-1, only 50% have learned by trial 20, and in C-2, only 37% have reached criterion.

If we take the 21st trial as an arbitrary point indicating failure to learn, then we can note that in Group E, only 20% fail to learn, in Group C-1, 40% fail to learn, and in C-2, 57% fail to learn.

TABLE 1

Means and Standard Deviations for Trials to Criterion in Visual Discrimination Training and Transfer of Learning

	Visual Discrimination Training		Transfer of Learning	
	$\bar{X}$	SD	$\bar{X}$	SD
E	12.27	6.39	12.10	9.21
C-1	4.03	0.18	17.66	10.11
C-2	12.27	6.39	20.30	9.43

TABLE 2

Analysis of Variance on Learning Letter Names

SV	df	MS	F
Among Groups	2	525.81	5.72^{xx}
1 (C-1 vs. C-2)	1	103.80	1.13
2 (E vs. C-1 + C-2)	1	946.60	10.29^{xx}
Within Groups	87	91.97	

xx $p < .01$

TABLE 3

Analysis of Variance for Errors to Criterion for Learning Letter Names

SV	df	MS	F
Among Groups	2	4981.11	5.92^{xx}
1 (C-1 vs. C-2)	1	135.00	0.16
2 (E vs. C-1 + C-2)	1	9827.22	11.68^{xx}
Within Groups	87	841.57	

xx $p < .01$

TABLE 4

Grouped Frequency Distribution of Trials
to Learn Letter Names

Trials to Learn	E	C-1	C-2
26-30	6	10	12
21-25	0	2	5
16-20	2	3	2
11-15	3	3	2
6-10	13	9	8
1-5	6	3	1

Finally, if we take the first ten trials as a measure of fairly rapid learning, then we see that about 63% of Group E subjects learn rapidly, whereas only 40% in C-1 and 30% in C-2 learn quickly.

Thus, we find rapid learning and few failures in Group E. In C-1 and C-2 learning is far slower with a much higher failure rate.

EXPERIMENT TWO - CLASSROOM STUDY

Method

Subjects. Subjects for this phase of the study were kindergarten children who had completed the first half of the school year. They were in regular classrooms, in either A.M. or P.M. sessions. Ten classrooms from four elementary schools cooperated.

All the children in each of the 10 classrooms were included in the study, for a total of 203 children.

Children within each classroom were randomly selected and randomly assigned to one of three treatments.

Because of illness, not all of the children provided usable data.

The actual number of subjects in each of the three treatments who provided usable data were: Group E = 63 subjects, Group C-1 = 60 subjects, and Group C-2 = 59 subjects, for a total of 182 subjects.

Materials

Practice Materials. A booklet was made showing how to do matching-to-sample exercises. The booklet contained practice examples for simultaneous and successive matching-to-sample exercises. Stimuli for the exercises consisted of easy to discriminate geometric forms. This practice booklet was used with all groups.

Visual Discrimination Training - Group E. Work books were designed for Group E in which matching-to-sample exercises were done.

The matching-to-sample visual discrimination training was given in two modes, simultaneous and successive. A special book was used for simultaneous and a different one for successive matching-to-sample discrimination training.

The booklets for simultaneous matching-to-sample had the standards and alternatives on the same page, permitting comparisons of standard and alternatives.

The booklets for successive matching-to-sample had the standards on one page and the alternatives on the next page to prevent comparisons. Thus, to mark the correct alternative in the successive mode, iconic memory of the standard was necessary.

Each week both simultaneous and successive discrimination work books were used. On Monday the simultaneous matching-to-sample book was used. On Tuesday and Wednesday the successive matching-to-sample book was used.

The simultaneous work book contained a total of 48 exercises. The successive work book contained a total of 36 exercises.

On week one the letters were y, h, k, t. On week two the letters were c, e, u, s. On week three the letters were h, u, v, n. On week four the letters were b, d, p, q.

Figure Three shows the standards and alternatives used with Group E.

A total of 14 different letters were introduced over the four-week period.

Visual Discrimination Training Materials - C-1. In terms of mode of discrimination training, i.e., simultaneous and successive, the C-1 materials were the same as those used by E. Materials for Monday required simultaneous discriminations, and for Tuesday and Wednesday, successive.

The actual stimuli used in the booklets can be seen in Figure 4. Note in Figure 4 that the standards used with C-1 are the same as those used with E. Although actual letters are used as alternatives with C-1, the critical difference is that the discriminations are not on a set of minimally contrasting pairs. However, letters are used as alternatives, as seen in Figure 4.

Week by week, the same set of letters were introduced as standards during discrimination training for C-1 as were used with Group E.

Visual Discrimination Training Materials - C-2. The simultaneous and successive training modes of presentation were used with this group in a manner which was similar to the other two groups.

Unlike the other groups, C-2 did not use letters for visual discrimination training. Instead, it used geometric forms. The stimuli used are seen in Figure 5.

Transfer of Learning. All groups used the same stimuli to learn letter names.

Each week the four letters taught changed as previously described.

Standards and Alternatives Used
in Matching-to-Sample for
Experimental Group

Standard	Alternatives			
b	b	d	p	q
d	d	b	p	q
p	p	b	d	q
q	q	b	d	p
h	h	u	v	n
u	u	h	v	n
v	v	n	h	u
n	n	v	h	u
c	c	e	u	s
e	e	c	u	s
u	u	e	c	s
s	s	e	c	u
y	y	h	k	t
h	h	y	k	t
k	k	y	h	t
t	t	k	h	y

Figure 3

Standards and Alternatives Used
in Matching-to-Sample for
Control-1 Group

Standard	Alternatives			
b	b	n	v	e
d	d	u	v	n
p	p	u	v	t
q	q	h	t	k
h	h	e	s	c
u	u	d	b	k
v	v	d	b	y
n	n	d	b	y
c	c	k	t	q
e	e	h	p	t
u	u	b	p	q
s	s	h	p	q
y	y	e	c	s
h	h	e	c	s
k	k	b	n	s
t	t	u	c	n

Figure 4

Standards and Alternatives Used
in Matching-to-Sample for
Control-2 Group

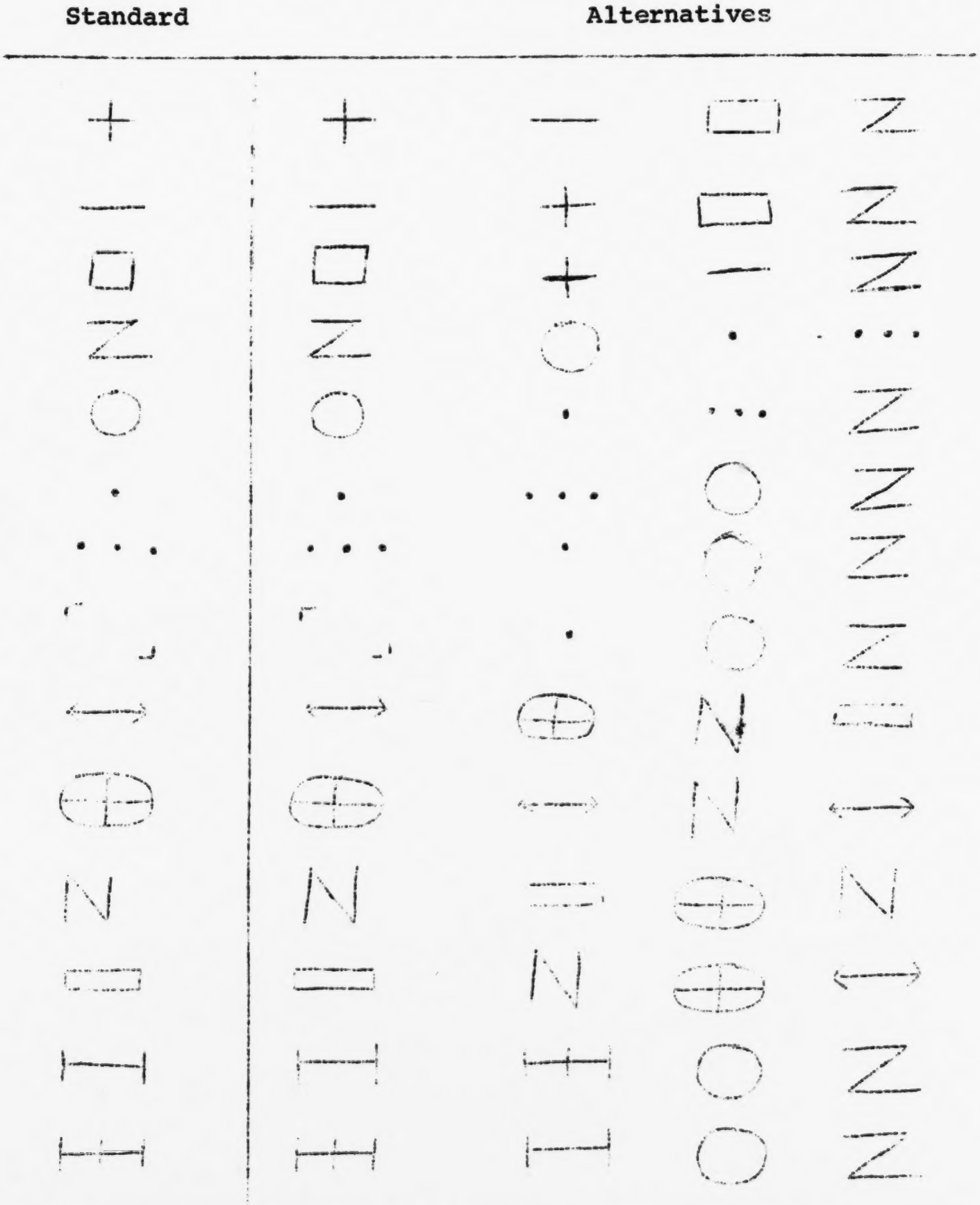


Figure 5

The materials used each week consisted of an overhead projector, one large transparency with 4 letters on it in block arrangement, and 4 small transparencies with one of the four letters on it.

The large transparency with 4 letters was used to permit simultaneous comparisons and observations.

The small transparencies with one letter were used to prevent simultaneous observation.

Pre-Test and Post-Test. There were two parts to these tests. For the "What letter is this?" part, the 14 letters used in the study were each typewritten on a 3 X 5 inch card, one to a card.

For the "Point to Letter ___" part, each 3 X 5 inch index card had 4 letters typed on it in block form. The four letters were minimally contrasting pairs such as h, u, v, n.

Weekly Tests. There were two parts to these tests as described above, a "What letter is this?", and a "Point to Letter ___." The four letters of the week were typed on cards as described above.

Procedure

Pre-test. Prior to any instruction, all subjects were given a pre-test on the 14 letters used in the study. This was done individually with each child. The letters were shown one at a time and the child was asked, "What letter is this?" Then he was shown an index card with four minimally contrasting letters and he was asked to "Point to the ___."

Assigning to Groups. Subjects were assigned to groups on a random basis. Within each class there were three treatment groups, one experimental and two controls.

Practice. Before the actual experiment began, the subjects were given the warm-up exercise to acquaint them with matching-to-sample exercises.

Visual Discrimination Training. Visual discrimination training was given on Monday, Tuesday, and Wednesday. Approximately twenty minutes was devoted to this training each day. The children were assigned to desks according to their group. Thus, all Experimental subjects sat together, Control-1 sat together, and Control-2 sat together.

On Monday simultaneous discrimination was given. On Tuesday and Wednesday, successive discrimination was given. On either mode of stimulus presentation, the task for the student was to locate the one letter (or geometric form) among the alternatives which matched the standard, and to mark it with a pencil.

Each classroom had an experimenter assigned to it. The experimenter in each of the ten classrooms was a student enrolled in a teacher-education training program.

(Note: All of the experimenters attended numerous workshop meetings in which the purpose of the study, its design, and procedures were discussed.)

The kindergarten students in each of the groups were not required to complete all the daily exercises. The reason for this was that the rate of working the exercises was an individual matter, some children working quickly and others slowly. Since we were given a set period of time in which to work, it was not possible to require each student to complete all the daily exercises. However, many did.

To encourage each child to work at an adequate rate, every classroom had a chart which read, "We Work Hard." A check mark was placed next to each child's name if he showed some attempt at working the exercises.

Once the materials were distributed, the experimenter walked about the classroom supervising the work of the children in all of the groups. The experimenter paid special attention to the accuracy of work.

Transfer of Learning - Teaching Letter Names. All the subjects received the same instruction. Letter name instruction was given on Thursday and Friday. The stimuli used for instruction were projected on a screen with a 3-M overhead projector.

Instructions were as follows:

Step 1

Ex. "For the last few days we have been working in our books on the letters. Today we are going to learn the names of the letters. What are we going to do today?"

Sub. "Learn the names of the letters."

Ex. "Look at this letter. It's name is v. Say v"

Sub. "v"

(Repeat for h, u, v, n. This is done in fixed sequence two times.)

Step 2

Use small transparencies with one letter on each transparency. Project each transparency, one at a time, in fixed sequence.

Fixed sequence: h, u, v, n
h, u, v, n 2x

Ex. "Look at this letter. Its name is h. Say h."

Sub. "h"

(Repeat for h, u, v, n. This is done in fixed order two times.)

Ex. "Listen carefully. Do what I tell you to do. Try to remember the names that go with each letter. What must you do?"

Sub. "Remember the names."

Ex. Puts large transparency with 4 letters in block form on projector. Takes a pencil and points to each letter in a fixed sequence, saying:

h u

v n

"Look at this letter. Its name is h. Say h."

Sub. "h"

Ex. "Look at this letter. Its name is u. Say u."

Sub. "u"

Step 3

Use small transparencies with one letter (one at a time). Present letters in random sequence. As each letter is on the screen, say:

Ex. "Look at this letter. Raise your hand if you know its name." (Call on a child.)

Sub. (Child gives answer)

Ex. "Yes, it is the ____. (or) No, this letter is ____."

(Go through set of 4 letters)
(Shuffle)
(Repeat procedure 4 times)

Weekly Test. A test on the four letters taught that week was given each Friday following instruction in letter-name learning. Testing was done individually. Procedures and materials were described earlier.

Post-Test. After four weeks of instruction, a test containing all the 14 letters used in instruction was given. Testing was done individually.

RESULTS

Pre-Test Scores - What Letter is This? At the start of the study each subject was given a pre-test of letter-name knowledge on the 14 letters used in the study.

Group E knew a mean of 5.38 letters (SD = 3.93, n = 63), Group C-1 knew 4.62 letters (SD = 4.26, n = 60), Group C-2 knew 4.50 letters (SD = 4.50, n = 59).

The analysis of variance on pre-test knowledge indicated no significant difference among the groups ($F < 1$, df = 2, 179).

Pre-Test Scores - Point to Letter___ At the start of the study, each subject was asked to point to the letter designated by the examiner. There were 14 letters in the test.

The mean correct responses for Group E was 5.52 (SD = 4.16, n = 62), Group C-1 was 5.23 (SD = 4.42, n = 60) Group C-2 was 6.03 (SD = 4.58, n = 59).

The difference between groups was not significant by analysis of variance ($F < 1$, df = 2, 178.

Post-Test Score - What Letter is this? At the completion of the study, each subject was given the 14 letter test. The mean number of letters identified by Group E was 7.15 (SD = 4.47, n = 60), Group C-1 was 6.75 (SD = 4.88, n = 56), Group C-2 was 7.95 (SD = 4.85, n = 57).

Analysis of variance indicated no significant difference among the means ($F < 1$, df = 2, 170).

Post-Test Score - Point to Letter-____. The mean number of letters ot which Group E responded correctly was 7.87 (SD = 4.55, n = 61), Group C-1 was 7.75 (SD = 4.74, n = 52), Group C-2 was 8.32 (SD = 4.56, n = 57).

Analysis of variance indicated no significant difference among the means ($F < 1$, df = 2, 167).

Difference Score - What Letter is This? The difference between pre-test and post-test scores was computed. Thus, if a subject knew 5 letters on the pre-test and 8 letters on the post-test, his difference score is 3. The difference score represents increment in letter-name knowledge.

The mean difference score for Group E was 2.00 (SD = 1.75, n = 60), Group C-1 was 2.41 (SD = 2.48, n = 56), Group C-2 was 2.47 (SD = 2.41, n = 57).

Analysis of variance indicated no significant difference among means ($F < 1$, $df = 2, 170$).

Difference Score - Point to Letter ___ . When instructed to point to a particular letter, the Group E difference score was 2.43 (SD = 2.75, n = 61), Group C-1 was 2.44 (SD = 2.84, n = 52), Group C-2 was 2.25 (SD = 2.35, n = 57).

No significant difference among mean difference scores was indicated by analysis of variance ($F < 1$, $df = 2, 167$).

Weekly Test - What Letter is This? A test was given at the end of each week of instruction. Table 5 shows the mean number of letters identified.

TABLE 5

Mean Number of Letters Identified
On Weekly Tests Under Instructions
To Name The Letters

Week		Group E	Group C-1	Group C-2
1)	y, h, k, t	$\bar{X}$ = 2.69	2.12	2.63
		n = 59	56	55
		SD = 1.37	1.65	1.46
2)	c, e, u, s	2.79	2.11	2.72
		59	57	53
		1.40	1.48	1.32
3)	h, u, v, n	2.86	2.83	3.00
		58	54	56
		1.52	1.42	1.27
4)	b, d, p, q	1.85	1.87	1.75
		61	52	55
		1.47	1.42	1.53

Analysis of variance on weekly tests indicated none of the F values were significant.

Weekly Tests - Point To A Designated Letter. Included in the weekly tests was the task of pointing to a letter indicated by the examiner. Table 6 shows the means for each treatment.

TABLE 6

Mean Number of Letters Identified
On Weekly Tests Under Instruction
To Point To A Designated Letter

Week		Group E	C-1	C-2
1)	y, h, k, t	$\bar{X}$ = 3.15 n = 58 SD = 1.41	2.89 56 1.41	3.35 55 1.21
2)	c, e, u, s	3.32 57 1.23	3.20 54 1.38	3.48 56 1.08
3)	h, u, v, n	3.17 58 1.35	2.68 57 1.42	3.07 54 1.23
4)	b, d, p, q	2.17 60 1.50	2.25 52 1.41	2.18 55 1.42

Analysis of variance on each of the weekly tests indicated none of the F values were significant.

Difference Scores on Weekly Tests - Letter Naming. The difference score was computed by subtracting any letter known on the pre-test from total correct on the weekly test. Table 7 shows the scores for each treatment.

TABLE 7

Difference Scores On Weekly Tests
Under Instruction to Name the Letter

Week		Group E	C-1	C-2
1)	y, h, k, t	$\bar{X}$ = 0.92 n = 59 SD = 1.09	0.96 56 1.22	1.05 55 1.10
2)	c, e, u, s	0.88 58 0.97	1.24 54 1.21	0.96 56 0.99
3)	h, u, v, n	1.39 59 1.10	1.14 57 1.13	1.40 53 1.17
4)	b, d, p, q	0.95 61 1.33	0.92 52 1.25	0.76 55 1.33

Analysis of variance on the weekly tests indicated none of the F values were significant.

Difference Scores on Weekly Tests - Pointing to a Designated Letter. Table 8 shows the results of the weekly tests.

TABLE 8

Difference Scores on Weekly Tests
Under Instruction to Point To A
Designated Letter

Week		Group E	C-1	C-2
1)	y, h, k, t	$\bar{X}$ = 1.32 n = 58 SD = 1.29	1.38 56 1.57	1.67 55 1.47
2)	c, e, u, s	1.28 57 1.37	1.24 54 1.26	1.27 56 1.30
3)	h, u, v, n	1.86 58 1.34	1.49 57 1.32	1.67 54 1.57
4)	b, d, p, q	1.35 60 1.49	1.48 52 1.43	1.29 55 1.13

Analysis of variance on weekly tests indicated that none of the F values were significant.

DISCUSSION AND RECOMMENDATIONS

The purpose of this study was to test a method of teaching children to name letters of the alphabet which was believed to be more effective than methods currently in use.

Although it appears from casual observation that children learn to name letters of the alphabet with ease, this is not necessarily the case. Despite long periods of instruction, some children have difficulty learning to name all of the letters.

The task of devising a more efficient way to teach letter-names has implications which extend beyond this particular instructional problem. Letter-name learning is an associative task, requiring a verbal label to be attached to a visual stimulus. Numerous educational tasks are similar to the letter-name learning task in that a distinctive label must be attached to stimuli which are similar in appearance.

The theoretical rationale for procedure used in this study was derived from two sources: first, from the literature on associative learning; second, from the literature on perceptual learning.

Recent thinking on paired-associate learning presumes that associative learning is complex, involving several stages. Breaking the task into its components and simplifying the learning involved with any component tends to simplify the total task.

The research on perceptual learning with a focus on errors made in matching-to-sample tasks indicates that most errors tend to occur with stimuli which share similar distinctive features.

In order to reduce the number of errors in a discrimination task when presented highly similar appearing stimuli, it is essential that one identify unique features for each stimulus in the set. The features which are unique to a particular stimulus make that stimulus identifiable and differentiates it from the others.

The features which are selected as distinctive are determined largely by the stimulus set in which the letters are placed. For example, when the stimulus set - b, i, v, k - is presented, the features selected for identification purposes are different than when the stimulus set - b, d, p, q - is presented.

When - b, i, v, k - is presented, it is possible to extract the circularity of the ball in letter "b" as the distinctive feature which differentiates it from the other letters in the set. Circularity is a useful feature within the particular set of letters used for discrimination training. If, however, b, d, p, q is presented later, circularity is not a useful feature, since b, d, p, q all share this feature.

The short-coming with many commercial and teacher prepared discrimination exercises is that there seems to be lacking the concept of training the student to note features of a stimulus which differentiate it from all the other 26 letters of the alphabet. In essence, the concept of distinctive feature analysis and training appears to be lacking.

In learning letter names for the 26 letters of the alphabet, it is important to give discrimination training so that the student will extract distinctive features for each letter of the alphabet.

The most efficient way to extract distinctive features is to provide discrimination exercises among a set of letters which tend to be confused with one another. Letters which tend to be confused with one another are: b, d, p, q; h, u, v, n; c, e, u, s; y, h, k, t; m, n, w, r; x, z, v, w; f, l, t, h; a, r, e, s; i, j, y, l.

In the laboratory described earlier in this report, the experimental group was given visual discrimination training on a set of letters which tend to be confused with one another.

The Control-1 group was given visual discrimination training on letters which are not readily confused with each other.

The Control-2 group was not given visual discrimination training.

Following visual discrimination training, all three groups were then taught to name the letters. The experimental group learned to name the letters significantly faster than the two control groups. There was no difference between the two control groups in speed of learning.

If one takes the twenty-first trial as an arbitrary cut-off point to indicate failure to learn, there are impressive differences among the three groups. Only 20% failed in Group E, 40% failed in Group C-1, and 57% failed in Group C-2.

Thus, one may conclude from the laboratory study that visual discrimination training on a set of figures which are easily confused is effective training for a verbal association task.

Although the laboratory investigation gave strong support to the hypotheses developed for this study, the classroom investigation failed to support these hypotheses. None of the analyses for the classroom investigation indicated any difference among the three groups.

Ex post facto analysis of reasons why the null hypothesis was not rejected in the classroom study indicates several possible sources of difficulty.

If visual discrimination training is to have positive transfer effect in learning letter names, two objectives should be fulfilled: (a) discrimination training should be given with a set of high similarity-easily confused letters so that the learner will extract the critical distinctive feature for each letter, (b) practice should be given until distinctive feature recognition is automatic. If, in the classroom study, the practice given to the experimental group did not enable them to extract the distinctive features and to recognize them quickly, then there should have been no difference among the groups.

A second source of possible difficulty involved the shift from observing the letters typed on paper to observing them projected on a screen with an overhead projector, and finally back to observing them on a card for the tests. Although the same typewriter was used to type the letters for each of the visual media, the media itself changed and so did the size of the letters. If transfer from one visual media to another was difficult, preventing transfer of learning, then failure to find differences among the groups is to be expected.

Whether or not children have difficulty in transfering learning from one visual media to another should be investigated.

The third possibility as to why differences among the three groups were not found is that the time spent in common with all the groups in learning the names may have been too extensive, thus obliterating any advantage produced by distinctive feature visual discrimination training. This possibility seems unlikely because of the generally low level of learning for all the groups.

The success of the laboratory study suggests that the theoretical rationale is sound. The lack of success in the classroom study suggests that the procedure is at fault.

The theoretical rationale for facilitating letter-name learning implies that:

1) verbal association tasks such as letter-name learning be separated into components.

2) facilitating the learning involved in any component should aid in the total task.

3) visual discrimination training should be given on a set of letters which are similar in appearance and which tend to be easily confused with one another.

4) visual discrimination training should be given until the student learns to recognize the distinctive features.

5) both simultaneous and successive discrimination with matching-to-sample or same-different judgments should be part of the procedure.

6) distinctive feature recognition should be at the automatic level.

7) letter-name paired-associate learning should follow visual discrimination learning.

8) instruction should be on part of the alphabet at a time rather than the entire alphabet all at once.

9) part of the learning should be on letter sets:
a, r, e, s; y, h, k, t; f, l, t, h;
h, u, v, n; i, j, y, l; x, z, v, w;
b, d, p, q; c, e, u, s; m, n, w, r.

10) after learning names for a set of letters, there should be regular review of these letters while studying new letter sets to reduce forgetting.

These procedures, which should be followed in learning letter-names of the alphabet, and the theoretical rationale underlying the procedures should apply equally well to learning other kinds of verbal association tasks in which

the learner must discriminate among sets of visual stimuli which are similar in appearance and apply distinctive labels to each of the stimuli.

The laboratory study on facilitating letter-name learning has provided empirical support for the soundness of the rationale underlying this study. The classroom study has pointed to the need for additional research to find practical and effective means for achieving the goal. At this stage of development, the problem is one of engineering and not theory. The critical task for the classroom is one of providing practice during visual discrimination which enables the learner to extract and automatically recognize the distinctive feature of each letter.

The laboratory study has provided empirical support for the underlying rationale on how to facilitate letter-name learning. The next stage of development should be classroom testing of procedures which will enable children to recognise distinctive features of letters so quickly that we may describe the recognition as being "automatic". Following feature recognition training, the children would then be taught to name the letters. Since evaluation of the procedures is of utmost importance, good research design is demanded during this stage of development so that valid conclusions can be drawn.

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